

## DEFINING STATE OF GOOD REPAIR

FTA is required by 49 U.S.C. 5326(b)(1) to establish “a definition of the term *state of good repair* (SGR) that includes objective standards for measuring the condition of capital assets of recipients, including equipment, rolling stock, infrastructure, and facilities.”

This definition will have a number of important consequences, including defining eligibility for projects under the State of Good Repair Grants Program (49 U.S.C. 5337) and defining what projects are excluded from eligibility under the Core Capacity Improvement Grants Program (49 U.S.C. 5309(e)). This definition will also set the benchmark for eligibility under the Pilot Program for Expedited Project Delivery (Section 20008(b) of MAP-21), which requires applicants to certify that their existing system “is in a state of good repair.”

Just as important, the definition of *state of good repair* will form the foundation for the state of good repair performance measure to be established by FTA (49 U.S.C. 5326(e)(1)). FTA grant recipients, MPO’s, and States will be accountable for setting transit state of good repair performance targets, and reporting on their progress towards achieving those goals. This process of setting targets and reporting on progress is expected to inform the process of investment prioritization, both in the transit asset management plans of individual transit systems, but also in formulating the transportation improvement program (TIP) and statewide transportation improvement program (STIP.) The definition and subsequent performance measure will also be incorporated into the National Public Transit Safety Plan (49 U.S.C. 5329(b)(2)(B)) and into each public transportation agency safety plan (49 U.S.C. 53299(d)(1)(E).)

Clearly, this definition of *state of good repair* will have far-reaching impacts. Indeed, this definition of *state of good repair* forms the cornerstone of the entire National Transit Asset

Management System envisioned by MAP-21 and currently being formulated by FTA. Defining *state of good repair* will establish a definitive benchmark by which the entire transit industry will be accountable for its stewardship of the assets needed to provide basic mobility to millions of Americans. Once defined, the expectations will be raised across the whole transit industry for prioritizing *state of good repair*.

This white paper describes four possible approaches for accomplishing this that were first discussed in our recent Announcement of Proposed Rulemaking (ANPRM), and discusses them in more detail than is possible in an ANPRM. These approaches are:

- Based on asset age;
- Based on asset condition;
- Based on asset performance; and a
- A comprehensive (combined) approach.

None of these approaches represent a perfect means of defining and measuring *state of good repair*. In particular, these approaches all make various trade-offs between precision and burden. In general, the simpler and less-burdensome the nature of the approach is, the less precise that approach is for defining and measuring *state of good repair*. On the other hand, the more precise a particular approach is at defining and measuring *state of good repair*, then so is the overall burden and complexity of that approach increased.

The guidance provided by statute for selecting one of these approaches is relatively limited. Only four criteria that place specific requirements on selecting a definition of *state of good repair* are provided: (1) The definition must “include objective standards for measuring the condition of capital assets;” (2) the definition must at least be applicable to “equipment, rolling stock, infrastructure, and facilities;” (3) the definition must allow a grantee to certify that its

existing system “is in a state of good repair;” (Section 20008(b) of MAP-21); and (4) the definition must lend itself to an implementable performance measure for purposes of 49 U.S.C. 5326(c) and the performance-based planning process in 49 U.S.C. 5303 and 5304. FTA recognizes that multiple approaches are capable of satisfying these requirements, including the four approaches identified above.

Related to defining *state of good repair* is the process of estimating long-term capital investment needs and making an investment prioritization. FTA currently uses the Transit Economic Requirements Model (TERM) to assess 20-year capital reinvestment needs using an age-based approach. TERM is used in the transit sections of the biennial Conditions and Performance Report to Congress and was also used in the 2009 Rail Modernization Report to Congress and in the 2010 National SGR Assessment. Several large agencies also use the same process to develop their long-term Capital Improvement Plans (CIPs). FTA supports transit agencies in using this approach by providing a simpler version of TERM, called TERM-Lite, for use by individual transit agencies in developing their CIPs. Although FTA has supported and supported an age-based approach in the past, MAP-21 has significantly changed the implications of defining *state of good repair*, and thus FTA is seeking comments on the pros and cons of implementing other approaches.

## APPROACH 1 – DEFINE STATE OF GOOF REPAIR BASED ON ASSET AGE

This approach relies on the assumption that most assets provide good service for a predictable period of time (adjusted by level of usage for some types of assets) after which they should be replaced. Although assets may continue to function safely and effectively at ages beyond this point, it is assumed that failure to replace assets at the end of this period of useful life leads to decreased performance, increased risk of in-service failure, and higher maintenance costs. In practice this construct can be used to meet MAP-21 asset management requirements in the following ways:

### a) CREATING AN ASSET INVENTORY

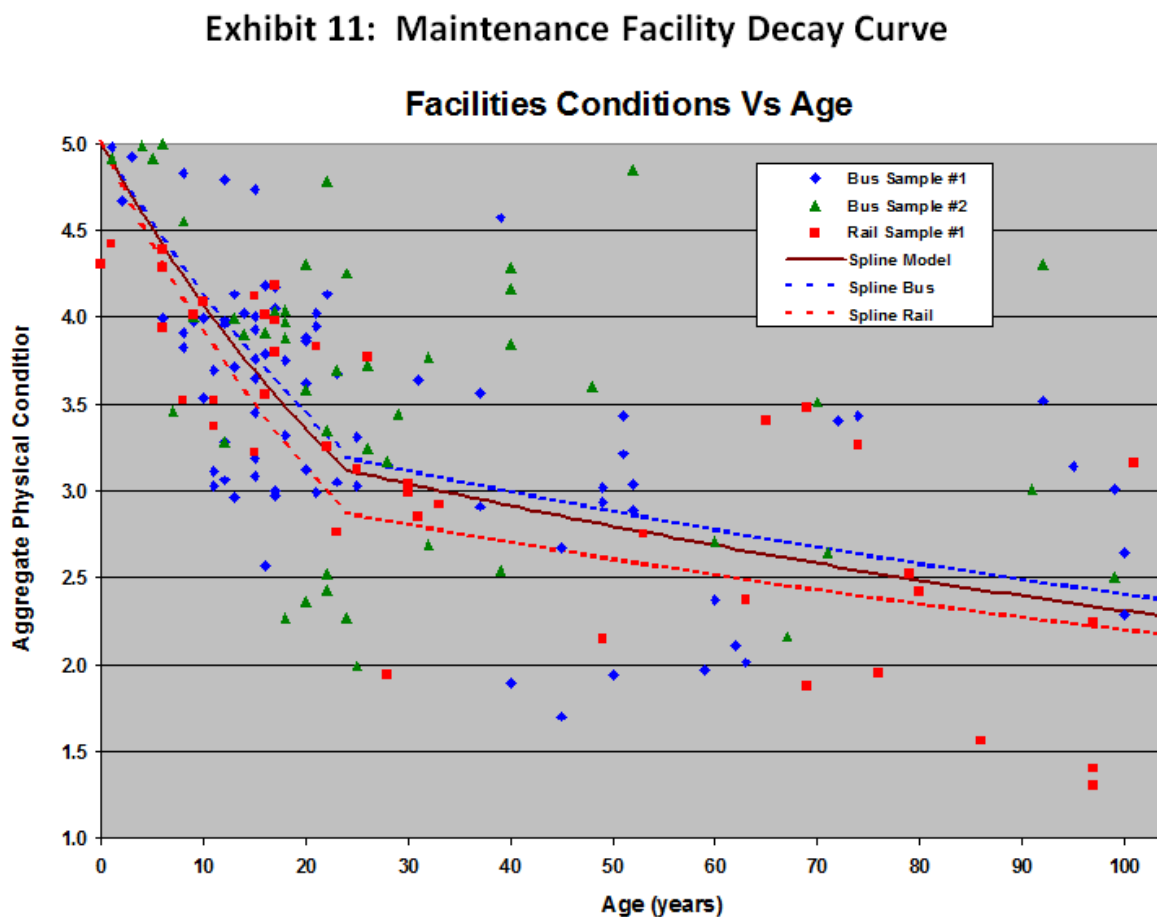
For each asset in the inventory, transit systems would need to identify the asset's location, age, and estimated replacement cost. For some assets, the level of use of the asset would also be required, for example, the mileage on a revenue vehicle or the average daily mileage on a track asset. Asset condition would not be directly assessed, but would be estimated from age and usage data. No condition inspection is required.

As part of with this approach FTA would develop and maintain a standard set of “decay curves” to allow estimation of condition based on the age and usage data in the asset inventory. A separate “decay curve” (age vs. average condition) would be established for each class of asset, in some cases with the class of asset being defined based on the level of use. For example, a forty-foot bus used under high-intensity conditions in a large city would be one class, whereas a forty-foot bus used under low-intensity conditions in a smaller city would be another class.

These decay curves, which FTA currently maintains for all asset categories as part of the Transit Economic Requirements Model (TERM), are based on FTA's research in the life-

cycle of transit assets. For the largest classes of assets, FTA uses random condition assessments done by teams of engineers to estimate a relationship between asset condition and age. For smaller classes of assets, FTA uses standardized curves developed from research into maintenance best-practices in the transit industry. FTA updates the TERM database and decay curves for use in preparing reports as required by Congress.

An example decay curve is show below for maintenance facilities:



As a practical matter, each decay curve would establish a *maximum useful life* for each class of asset, beyond which the asset would be considered to be part of the *state of good repair backlog*. This *maximum useful life* is set at the age where the decay curve reaches condition 2.5. For example, in the above decay curve, maintenance facilities reach condition

2.5 at 80 years of age. Thus, once a maintenance facility reached 80 years of age, it would be considered to be part of the *state of good repair backlog*.

It is important to note that a *maximum useful life* is much different from the *minimum useful life* that many grantees are already familiar with. The latter establishes a threshold age, before which a Federally-funded asset cannot be replaced without assuming liability for the Federal interest in the asset. The former, on the other hand, establishes a threshold age beyond which the asset is no longer considered to be in a state of good repair. In most, if not nearly all cases, the asset may still be capable of functioning in the safe and effective delivery of transit service beyond the *minimum useful life*, after all this age is only a minimum. In some cases, the asset may still be capable of functioning in the safe and effective delivery of transit service beyond the *maximum useful life* as well. After all, FTA estimates that the transit industry currently provides over 10 billion trips per year, even while operating with an estimated \$78 billion backlog. Nevertheless, this threshold would indicate the point at which the asset is due for replacement in order to achieve a *state of good repair*. Keeping an asset in service beyond this point would be expected to correlate with one or more of the following: increased safety risks, lower reliability, higher maintenance costs, or decreased overall performance.

#### b) EVALUATION OF THE APPROACH

FTA has identified a number of potential pros and cons to this approach and offers them for consideration by commenters.

Pros:

- The “age-based” approach is compatible with existing CIP processes in many large agencies, and with FTA’s current method of measuring the state of good repair backlog.

- This approach is relatively objective and easy to implement. The age of most assets can be objectively determined from maintenance or procurement records. The estimated replacement cost of assets can also be objectively determined in many cases from procurement records, although estimation may need to be used for legacy assets.
- This approach does not require asset condition inspections, which can be labor-intensive. Condition assessments also have an inherent degree of subjectivity both across personnel within an agency, and from one agency to another.
- The minimum requirements for an asset inventory under this approach would likely be very similar to the level of detail required by the asset inventory to be reported to the National Transit Database. Individual transit systems could choose to supplement this approach with additional data in their internal asset inventories in order to refine their own transit asset management plans.
- This approach has a low maintenance burden, since data on assets only needs to be updated when the assets are modified, rehabilitated, taken out of service, or are added “new” to the inventory. The minimum requirements for a TAM plan would not require establishing a cycle for re-assessing conditions and updating condition assessments.
- The level of effort to implement this approach is roughly proportional to system size, so transit systems with fewer assets will inherently have a lower burden.

Cons:

- This approach does not capture the impact of newer assets in poor condition or older assets in good condition. Rather, a condition estimate for an individual asset is the average condition for that type of asset at that same age.

- The appropriate replacement threshold, or *maximum useful life*, for a given class of assets will likely need to be defined to be relatively generously in order to minimize the number of assets in good condition that get included in the state of good repair backlog for an individual transit system.
- Establishing a relatively generous threshold for *maximum useful life* will also mean that some assets that have been maintained in a below average condition for their age will not be classified in the state of good repair backlog. This would not provide incentive for more aggressive maintenance of such assets.
- This approach may not be suitable for cases where assets are few in number and have very long useful lives. For example, relatively few tunnels have been replaced in the history of public transportation in the United States, so the expected useful life of a tunnel is harder to define in terms of a *maximum useful life* than that of other assets.
- This approach may not be suitable for cases where assets are relatively diverse even within a certain asset class. For example, bridges may vary substantially in their form of construction, and this may result in large variations in anticipated useful life from one individual bridge to another.

## APPROACH 2 – DEFINE STATE OF GOOD REPAIR BASED UPON CONDITION OF ASSETS

This approach is based on periodic condition assessments of all assets using a set of standardized procedures and criteria. Assets with longer life expectations, such as buildings, can be inspected less frequently than assets with shorter life expectancies, such as vehicles. Small, numerous, assets (e.g. rail ties) may be sampled, as determined by yet to be developed FTA



standard procedures, with the average condition of the sample being applied to all assets in the category.

In practice, this would require a highly systematic approach to data collection, such as a track-assessment process that would develop comprehensive scores for rail guideway segments (and might include rail, ties, fasteners, frogs, etc.) Determining bus condition might require separately inspecting individual components (tires, brakes, frame, lifts, CNG fuel containers, etc.)

#### a) CREATING AN ASSET INVENTORY

Asset inventory data at the agency level would be maintained at a relatively fine level of granularity. For example, a condition assessment for a building (e.g. a passenger station or a maintenance facility) would typically require inspection of the roof, the HVAC systems, the building structure, etc. An appropriate analogy might be a home inspection, where a checklist is used to inspect different components of the home before reaching an overall assessment of condition. Asset inventory data would be reported to the NTD, on the other hand, at a fairly high level as appropriate for the Federal interest – e.g. for a station as a whole, or a vehicle as a whole. For the agency-level asset inventory, however, each transit system would need to record the condition of each asset as determined using the standard procedure for that asset, the date of the last inspection of the asset, and the required inspection frequency for the asset.

Under this approach, FTA, in conjunction with stakeholders, would develop and maintain a standard set of procedures and criteria for inspecting each type of asset. FTA is not aware of an existing industry standard in this regard, which would be needed to increase the objectivity and uniformity of the assessments. These standards would presumably include a required frequency of inspection and a checklist of measures and tests to perform that are

specific to each asset. FTA would provide training and appropriate technical assistance. As noted earlier, the condition assessments would likely need to be at a more-detailed level than FTA would require for meeting the statutory requirements to report asset inventories and condition assessments to the National Transit Database.

#### b) DECISION SUPPORT TOOLS AND INVESTMENT PRIORITIZATION

Under this approach the condition of each asset is known based on the asset's most recent condition assessment, and a projection based on the asset's known life-cycle and the time since the most recent condition assessment. The state of good repair backlog is determined on the basis of the replacement value of all assets below an established condition threshold. A program of state of good repair projects is developed based on assets in the state of good repair backlog and assets projected to reach the end of their useful lives in the near term.

#### c) EVALUATION OF THE APPROACH

FTA has identified a number of preliminary pros and cons to this approach for consideration by commenters.

##### Pros:

- Identifies assets that may fail well before the end of their life expectancy due to heavy use, defects, poor installation, lack of maintenance, or stress from severe incidents are identified through inspections.
- Captures the impact of investment strategies that use systematic preventative maintenance to prolong asset life beyond the average useful life for that asset. Thus older assets that have been well maintained may still be considered to be in good repair.
- At most agencies, critical assets are already subject to some level of regular inspection.
- Valuable for oversight of agency maintenance activities.

Cons:

- Much of the effort needed to set up the condition assessment processes and training required for this approach is independent of agency size. Small transit systems and large systems alike will need to develop condition assessment skills and databases. This may represent a disproportionately larger effort for small agencies.
- The burden for conducting a comprehensive condition assessment of a transit system's entire asset inventory is much higher than the burden of simply establishing the age of each asset.
- The on-going burden of this approach is also higher, as condition assessments only reflect condition at that particular time, and so must be continually updated in a systematic way.
- This approach could require FTA to develop extensive additional guidance on conducting condition assessments, guidelines for updating condition assessments, etc. FTA is not aware of currently available documentation for these practices.
- There have been many examples of situations where inspections have failed to detect defects in older assets. Some older assets also become obsolete, often by not incorporating the latest safety features. Thus, a condition-based approach may need to be combined with a modified age-based approach, in which standards are still set for the replacement of an asset based on age, regardless of the results of condition inspections.
- A condition-based approach is most-valuable for managing existing assets in the shorter term. Long-term investment prioritization will still be based on useful life expectancies, though these estimates can be improved using historic condition assessment data.

APPROACH 3 – DEFINE STATE OF GOOD REPAIR BASED ON PERFORMANCE OF ASSETS

This approach is based on regular, comprehensive, assessment of system performance. Performance metrics for all aspects of system operation are developed and tracked to identify infrastructure and operational issues that need to be addressed through prioritization of capital investment or through improved management practices. This approach has not been tested on transit systems in the United States but was the basis for public oversight of the public-private partnership that briefly ran the London Underground. It has, however, been successfully applied in other domestic utility industries.

A performance-based approach would require far tighter integration of operations and capital maintenance than currently exists at most agencies. Performance issues that could be tracked to infrastructure problems would clearly indicate SGR problems. However, operational work-arounds may mask infrastructure problems and present as problems in other areas. Purely operational issues also affect performance measures – even a new bus can't produce good performance if schedules are unrealistic or drivers are disgruntled. Ultimately, this approach will encourage a comprehensive management awareness of risk factors on both sides of the capital/operating split and a commitment to determining the best allocation of resources across both sides to address the most pressing threats to meeting agency objectives.

A performance-based definition would also involve far greater FTA oversight of transit operations, at a much-greater level of detail than currently occurs today. Standard industry performance metrics would need to be defined, collected, and audited. To be manageable, some level of self-certification would probably be required. In practice this construct can be used to meet MAP-21 asset management requirements in the following ways:

a) CREATING AN ASSET INVENTORY

Transit systems would need to collect the location, age, and replacement value of each asset in their inventory, as well as some data on asset usage, just as in the age-based approach. In addition, agencies would need to maintain a process for linking performance issues to underlying problems with asset condition. This would include an ability to evaluate the probability of asset failures and the impact they would have on system performance. Thus an agency could prioritize resources to proactively address infrastructure problems on the basis of their risk to agency operations.

FTA would define a series of metrics to characterize the many aspects of a transit agency's service that can be affected by the condition of the underlying infrastructure. Examples include safety, on-time performance, travel times, customer wait times, mean time between vehicle failure, ride quality, cleanliness of facilities, missed stops, cost per passenger mile, and customer satisfaction. Since transit operations also affect these measures it may also be necessary to collect some purely operational metrics (e.g., overtime, vacancies, weather-related disruptions) to help identify where asset condition is a contributing factor.

#### **b) DECISION SUPPORT TOOLS AND INVESTMENT PRIORITIZATION**

A new framework would need to be developed for systematically tracking operational data. Operational measures are, by their nature, sensitive to weather and other external events as well as being subject to random variations for unknown reasons. They are usually derived directly from agency performance objectives (asset condition metrics have a less direct connection). Operational metrics tend to be reported monthly or quarterly, to allow for better tracking of progress for these more volatile measures. Underlying asset conditions evolve on a longer time scale and, accordingly, are reported less frequently.

#### **c) EVALUATING THE APPROACH**

FTA has identified a number of preliminary pros and cons to this approach for consideration by commenters.

Pros:

- Most agencies already collect operational measures for their own use.
- Captures the impact of investment strategies that use intensive maintenance to prolong asset life or that use frequent replacement of assets to avoid maintenance costs.
- Valuable for oversight of agency operations at all levels. Resulting performance measures and goals are easy to understand and can be updated frequently.

Cons:

- This approach would involve closer FTA oversight of transit operations at a greater-level of detail than is currently the case. Uniform data on agency performance would be available to the public, allowing them to compare their transit service with service in other localities.
- This approach will require FTA to develop extensive guidance on what performance measures are to be tracked, and the process for tracking them.
- This approach will require more frequent reporting of data to FTA, as the operational performance measures must be continually tracked.
- This approach may not be suitable for assets where declining condition may not produce any notable impact on performance, such as bridges. It may also fail to anticipate developing safety problems, as major accidents are too rare to serve as indicators of underlying asset condition problems.
- Provides limited support for short-term capital investment project development.

- Although the operational performance measures, when combined with appropriate context, may be suitable for identifying performance issues that indicate that the transit system is not in a state of good repair, it is not possible to quantify the size of the state of good repair backlog for an individual transit system under this approach without also collecting age and other data as describe in approach 1.

#### APPROACH 4 – DEFINE STATE OF GOOD REPAIR BASED ON A COMPREHENSIVE ASSESSMENT OF ASSETS

This approach combines the previous approaches to look at the age, condition, and performance of a system's assets. Condition ratings are a weighted combination of metrics for all the above considerations, including asset age, condition assessments, system performance, and the maintenance history of the asset. The objective here is to promote a comprehensive approach to managing assets that integrates performance objectives, maintenance management, short term capital project planning, and long term CIP planning, into a holistic process for resource allocation. This approach is data intensive, so much so that FTA would not collect it all. However, agencies that successfully implement this approach will have achieved a level of asset management maturity that would allow them to self-certify compliance with SGR requirements.

# ASSET CRITERIA AND SCORING SYSTEM

# CONDITION RATING

| Asset Rating Score | Asset Age  | Asset Condition   | Asset Performance  | Level of Maintenance  | Asset Condition Rating |               |
|--------------------|--|---|--|---|------------------------|---------------|
|                    | (Percent % of Useful Life Remaining)                   | (Quality, Level of Required Maintenance)  | (Reliability, Ambience, Safety, Meets Industry Standards)                          | (Level of Preventative and Corrective Maintenance)                                      | Rating Description     | Scoring Range |
| 5                  | Asset new or nearly new<br>75% - 100%                  | Asset new or like new; no visible defects   | Asset meets or exceeds all performance and reliability metrics; industry standards | No unfunded or deferred maintenance activities  | Excellent              | 4.4 to 5.0    |
| 4                  | Asset nearing or at its midlife point<br>50% - 75%     | Asset showing minimal signs of wear; some slight defects or deterioration           | Asset generally meets performance and reliability metrics; industry standards      | Some temporary deferrals of PM and CM; but no activities skipped completely             | Good                   | 3.4 to 4.3    |
| 3                  | Asset has passed its midlife point<br>25% - 50%        | Some moderately defective or deteriorated components; expected maintenance needs    | Occasional performance and reliability issues; may be sub-standard in some areas   | More frequent and extended deferrals of PM and CM; some activities skipped altogether   | Adequate               | 2.5 to 3.3    |
| 2                  | Asset nearing or at end of its useful life<br>0% - 25% | Increasing number of defects, deteriorating components; growing maintenance needs   | Performance and reliability problems becoming more serious; sub-standard elements  | PM and CM activities frequently delayed or skipped until major problems surface         | Marginal               | 1.8 to 2.4    |
| 1                  | Asset is past its useful life                          | Asset in need or replacement or restoration; may have critically damaged components | Frequent performance and reliability problems; does not meet industry standards    | Significant backlog of PM and CM work due to history of deferred and skipped activities | Poor                   | 1.0 to 1.7    |
| 0                  | Asset non-operable                                     | Asset non-operable  | Asset non-operable   | Asset non-operable  | Non-Operable           | 0             |

In SGR ≥ 2.5  
SGR 2.50  
Not SGR < 2.5

## SAMPLE SCORING BASED ON PREDETERMINED WEIGHTINGS (ILLUSTRATION ONLY)

| Asset Age | Asset Condition | Asset Performance | Level of Maintenance | Asset Condition Rating |
|-----------|-----------------|-------------------|----------------------|------------------------|
| 20%       | 30%             | 30%               | 20%                  |                        |
| 3         | 3               | 2                 | 3                    | 2.70                   |

## a) CREATING AN ASSET INVENTORY

In practice this approach would build on a detailed asset inventory with condition assessments as in approach 2 and supplement it with age and performance data for a comprehensive picture of how well an agency's assets are supporting operational goals. However, the law only requires that an asset inventory, condition assessments, and SGR performance goals and progress be reported to the National Transit Database.

## b) DECISION SUPPORT TOOLS AND INVESTMENT PRIORITIZATION

The comprehensive approach produces a detailed condition assessment for each asset based on the asset's age, its most-recent condition inspection, the asset's performance, and the asset's maintenance history. This information is combined with information on risks associated with asset failure and on how critical the asset is to agency performance. Project



development information, such as the asset's cost and proximity to other assets in need of replacement, is also available to support development of reinvestment projects in the two-to-three year time frame.

#### c) EVALUATING THE APPROACH

FTA has identified a number of preliminary pros and cons to this approach for consideration by commenters.

##### Pros:

- Covers all the major determinants of an asset's condition (age, condition, and performance).
- Avoids the problems of solely age-based, condition-based, and performance-based approaches
- Supports capital investment planning at all levels
- Encourages a more systematic approach to capital reinvestment processes that already occur to some extent at most agencies.

##### Cons:

- This approach requires a greater burden of effort, since it includes some or all of the requirements of all the preceding approaches.
- Will require agencies to coordinate operations, maintenance management, and capital planning in a way that may be unprecedented for some transit systems.
- This approach may require FTA to develop extensive guidance and technical assistance for implementation.

- This approach is hard to specify in that how each agency implements it will depend on their management processes, data systems, modes operated, and size. Formalizing and documenting this process may place a relatively greater burden on small transit operators.